Galgotias University, Greater Noida
Winter 2020-21

Course Handout		
1	**Course details**	
	Faculty name	
	Programme	B.Tech
	Semester	II
	Section	
	Course code	BBS10T1003
	Course title	Linear Algebra and Differential Equations
2	**Vision of the Department of Computer Science and Engineering**	
	To be known widely as a premier department of Computer Science and Engineering for value-based education, multidisciplinary research and innovation.	
3	**Mission of the Department of Computer Science and Engineering**	
		The mission of the Computer Science and Engineering Department is 1. Create a strong foundation on fundamentals of SCSE through OB-TLP. 2. Establish state-of-the-art facilities for Analysis, Design and Implementation to develop sustainable ethical solutions. 3. Conduct multidisciplinary research for developing innovative solutions. 4. Involve the students in group activity including that of professional bodies to develop leadership and communication skills.
4	**Programme educational objectives (PEOs)**	
	PEO1	Graduates of Computer Science and Engineering will be globally competent and provide sustainable solutions for interdisciplinary problems as team players
	PEO2	Graduates of Computer Science and Engineering will engage in professional activities with ethical practices in the field of Computer Science & Engineering to enhance their own stature to contribute society
	PEO3	Graduates of Computer Science and Engineering will acquire specialize knowledge in trending technologies for research, innovation and product development
	PEO4	

5	**Programme outcomes**					
	PO1	Engineering Knowledge				
	PO2	Problem analysis				
	PO3	Design/development of solutions				
	PO4	Conduct investigations of complex problems				
	PO5	Modern tool usage				
	PO6	The engineer and society				
	PO7	Environment and sustainability				
	PO8	Ethics				
	PO9	Individual or team work				
	PO10	Communication				
	PO11	Project management and finance				
	PO12	Life-long Learning				
6	**Programme specifics outcome(PSO) (if any)**					
	PSO1	To train them in trending technologies.				
	PSO2	To introduce upcoming domains like artificial intelligence, Robotics, Augmented reality, Data analytics, Ubiquitous Computing to develop insights for problem solving.				
	PSO3					
7	Course outcomes (COs)					
	CO1	Determine Matrix algebra, invertibility, rank and Solve systems of linear equations using Gauss elimination and Cramer's rule.(K5,K3)				
	CO2	Find real Vector spaces & Linear transformation and summarize various terminologies & properties associated with. (K1,K2)				
	CO3	Evaluate eigenvalues and eigenvectors and their properties. Discuss inner product spaces and orthogonalization. (K5,K6)				
	CO4	Apply appropriate methods to solve nth order linear ordinary differential equations (K3,K6)				
	CO5	Classify partial differential equations and apply method of separation of variables to solve PDE.(K3,K4)				
	CO6	Apply normal form of Matrices to find Rank.				
8	Evaluation Component	Duration	Marks (50)	Date &Time	Nature of Component	Evaluation Component
	MTE	2 Hrs	50		Closed Book	MTE
	Quiz-1/2/3	15 mins each	5		Closed Book	Quiz-1
	Online Learning using Swayam/NPTEL/Coursera(s	45 mins	5		Closed Book	Quiz-2

	elflearning)					
	Assignment(s)	Within two days	5	Any time throughout the semester	Open Book	Assignment(s)
	Presentation(Seminar/mini-project/poster)	15 minutes	5	On a scheduled date	-	-
9	List of teaching –learning pedagogy :White Board, e- book, Power Point Presentations, Internet Resources, NPTEL Web, Swayam and Video courses.					
10	Open hour for students: As per the Time Table					
11	RF CAMPUS					
12	Recommended list of e-books. URL- http:// http://nptel.ac.in/courses/122104018/ URL- http://nptel.ac.in/courses/122103012/					
13	Recommended list of online courses like SWAYYAM/NPTEL/MOOCS etc					
14	Recommended list of mini projects / projects/ technical training etc.					
15	Students' Presentation :					
16	**List of e-books**. URL- http:// http://nptel.ac.in/courses/122104018/ URL- http://nptel.ac.in/courses/122103012/					
17	List of NPTEL/MOOCS/SWAYAM/Courses/Video					
18	Content beyond Syllabus:					
19	List of mini projects/projects					

Winter 2019-20

BMA201 (Linear Algebra and Differential Equations)

B.Tech. First Year

Second Semester

Lecture Plan

Faculty Name:

Lecture No.	Date	Learning Outcomes	Topics To Be Covered	Book (Section/Page	Remark

				No./Author)	
Unit-I: Matrices				**Contact hours: 6**	
1.		Matrices: Basic Concepts	Matrix, vectors, Determinants: Definition, addition and scalar multiplication. Matrix multiplication. Transposition of matrix, vectors. Some special square matrices: symmetric and skew symmetric matrices, orthogonal matrices, upper and lower triangular matrices, Diagonal matrix.	(7.1,7.2/257/T2) (3.0/136/T1)	
2		Elementary row transformation	Inverse of a matrix(Using Gauss Jordan elimination method),	(3.3/163/T1) (3.3/175/T1) (7.8/301/T2)	
3-4			Rank of a matrix	(7.4/ 283/T2) 3.5/191/T1)	Discuss LI and LD of Vectors(Topic of unit-II)
5		System of Non-Homogeneous Linear Equations	Existence and uniqueness of the solution of non-homogeneous system AX=b using rank, finding solutions by simple Gauss elimination method and also by Cramer's Rule	(2.0/58/T1) (7.5/288/T2) (7.3/279/T2) (7.7/297/T2)	
6		System of Homogeneous Linear Equations	Trivial and non-trivial solutions of Homogeneous system AX=0, finding non-trivial solutions by simple Gauss elimination method	(7.5/288/T2) (2.0/57/T1)	
Unit II : Vector Spaces-I				**Contact Hours: 10**	
7.		Vector Space	Definition of vector space,	(7.9/309/T2)	
8.			Linear independence and	(6.0/427/T1)	

			dependence of vectors,	(6.0/443/T1)	
9.			Basis and dimension	(3.3/3.3.3/3.26/R1) (6.2/443/T1)	
10.		Linear Transformation	Definition of Linear transformations,	(3.3/3.3.4/3.29/R1)	
11.			range and kernel of a linear map,	(6.4/472/T1)	
12.			Rank and nullity of Linear transformation	(6.5/481/T1)	
13.			rank- nullity theorem(only statement) and its applications	(6.7/518/T1)	
14.			Composition of Linear map	(3.6/219/T1)	
15.			Inverse of linear transformation,	(3.6/221/T1)	
16.			Matrix associated with linear map	(6.6/497/T1)	
Unit-III: Vector Spaces-II					**Contact Hours: 10**
17.		Eigen value problem	Defining Eigen values and Eigen vectors of a square matrix, Symmetric, Skew Symmetric& Orthogonal Matrix.	(8.1/323/T2)	
18.			finding Eigen vectors corresponding to distinct Eigen values .	(4.1/254/T1)	
19.		Eigen value problem (Continued…)	Finding Eigen vectors corresponding to repeated Eigen values	(8.1/323/T2) (4.1/254/T1)	

20.		Eigen value problem (Continued…)	Properties of Eigen values and eigen vectors	(3.51/3.63/R1) (4.3/292/T1)	
21.		Eigen bases	Define and explain eigenbasis of eigen vectors	(8.4/339/T2)	
22.		Diagonalization	Similar matrices, defining diagonalization of a square matix, necessary and sufficient condtion for a matrix to be digonalisable.	(8.4/340/T2) (4.4/301/T1) (3.5.2/3.71/R1)	
23.		Diagonalization(continued…)	Determining whether a matrix is diagonalizable, Diagonalising a matrix	(8.4/340/R1) (4.4/301/T1)	
24.		Inner Product Space	Revision of definition of field, and define inner product space (for complex and real field both) with examples	(7.9/309/T2) (3.9/3.9.4/3.99/R1) (7.1/531/T1)	
25.		Gram-Schmidt orthogonalizations	Define orthogonal sets and orthonormal sets with examples.	(5.0/368/T1)	
26.			Define Gram-Schmidt orthogonalizations process and Solve problems related to its application.	(3.9/3.9.4/3.99/R1) (5.3/388/T1)	
Unit-IV: Ordinary Differential Equations				**Contact Hours:**	**10**
27.		Exact differential equation	Defining first order exact differential equation, necessary and sufficient condition, General solution.	(1.4/20/T2)	
28.		Homogeneous linear differential equation with constant coefficients	nth order homogeneous linear equation f(D)y=0,linear independence of solutions, auxiliary equation, solution: when roots of auxiliary	(2.1,2.2,2.3/46/T2) (5.1/5.1/R1)	

			equation are a) distinct, b)equal, c)complex.		
29.		Non-Homogeneous linear differential equation with costant coefficients	nth order non-homogeneous linear equation f(D)y=r(x), general solution =Complimentary function+ particular integral, method to find PI when $r(x)=e^{ax}$	(2.7/79/T2) (5.5/5.44/R1)	You may Consider finding PI by the method of undeter mined coefficie nts
30.			method to find PI when r(x)= sinax, cosax	(5.5/5.44/R1)	
31.		Non-Homogeneous linear differential equation with costant coefficients (Continued…)	method to find PI when $r(x)=x^n$,	(5.5/5.44/R1)	You may Consider finding PI by the method of undeter mined coefficie nts
32.			method to find PI when $r(x)=e^{ax}V(x)$, x^nsinax, x^ncosax	(5.5/5.44/R1)	
33.		Variation of parameter method	Variation of parameter method to find PI of a second order linear differential equation.	(2.10/99/T2)	
34.		Cauchy-Euler equations	Cauchy-Euler equation and its solution.	(/2.5/72/T3) (2.5/71/T2)	
35.		System of linear differential equations with constant	Finding solution of a system of linear equations.	(5.6/5.55/R1)	

		coefficients			
36.		Application of Linear Differential Equations to Electric circuits	Mathematical modeling. Basic elements of an electric circuit, Kirchhoff's law, solution of simple LR and CR circuits	(1.1/2, 29/T2)	
UNIT-V : Partial Differential Equation				**Contact Hours: 9**	
37.		PDE	Basic concept and classification of second order PDE	(9.5/9.5.1/R1)	
38.		Solution of PDEs by Separation of Variable method	Separation of variable method to solve second orders linear homogeneous PDEs with constant coefficients.	(12.1/540/T2)	Simple problems only
39.			Continued...	(12.1/540/T2)	
40.		Solution of one-dimensional wave equation	One dimensional wave equation as mathematical model of vibrations of a stretched string, solution of 1-dim wave equation by SOV method.	(12.2,12.3/543/T2)	
41.		Solution of one-dimensional wave equation(continued...)	solution of 1-dim wave equation with different initial conditions.	(12.3/545/T2)	
42.		Solution of One-dimensional heat equation	One dimensional heat equation as mathematical model for the temperature distribution in a thin heated rod. Solution of 1-dim heat equation with both ends of the rod at 0^0.	(12.5,12.6/557/T2)	
43.		Solution of One-	Solution of 1-dim heat equation	(12.6/563/T2)	

		dimensional heat equation(continued…)	when the rod has insulated ends.		
44.		Solution of Two dimensional Laplace equation.	Two dimensional Laplace equation as a mathematical model for the steady state temperature distribution in a thin rectangular plate, solution of the equation	(12.6/564/T2)	
45.		Solution of Two dimensional Laplace equation(continued…)	Solution of Laplace equation with different boundary condtions.	(12.6/564/T2) (9.5.5/9.48/R1)	
Module-Vi :Normal form of Matrices and It's Application				**Contact Hours-3**	
46-48		Normal form of Matrices and It's Application	Normal form of Matrices and It's Application		

Course Description

Unit-I: Linear algebra is the study of **linear** systems of equations, **vector spaces**, and **linear** transformations. In this unit we study **Matrices and Vectors**. The common threads that run through the entire unit are elementary operations of a matrix, rank of a matrix and solution of system of linear equations by simple Gauss elimination method. We use these tools to find solution to the Inverse problem. **Unit-II:** It is introduction of Vector Space , Linear Independence of vectors. For a given linear transformation, find the kernel and range, find the basis for the kernel and range, and determine the nullity and rank.**Unit-III:** This unit contains the study of the characteristic equation and the eigenvalues and corresponding eigenvectors of a given matrix. Determine whether a given matrix is diagonalizable, symmetric, or orthogonal. Find (if possible) a nonsingular matrix P for a given matrix A such that $P^{-1}AP$ is diagonal. **Unit-IV :** This unit deals with solution of **Ordinary Differential Equations**. The focus is on nth order linear differential equations of homogeneous as well as non-homogeneous type with constant coefficients. Variation of parameter method is introduced to find a particular integral of a second order linear equation. This method is important as it is also valid for variable coefficient problems. Solutions of Cauchy-Euler equation and system of linear differential equations with constant coefficients are obtained by reducing them to a single linear differential equation with constant coefficients. In the end we

solve some simple electric circuit problems as they are perfectly modeled by the type of differential equations we studied earlier in this topic. **Unit-V:** Three important **Partial Differential Equations**, namely, 1-dim wave, 1-dim heat and two dim Laplace equations are mathematical models of various engineering problems. In this unit we find solution of these equations by separation of variable method and using Fourier series expansion.

Text Books:

T1. D. Poole**, Linear Algebra: A Modern Introduction,** 4th Edition, Brooks/Cole, 2015.

T2. *Erwin Kreyszig*, **Advanced Engineering Mathematics,** 10th Edition, John Wiley & Sons.

T3. *Peter V. O'Neil,* **Advanced Engineering Mathematics,** 7th Edition, Cengage Learning.

Reference Books:

R1. *R. K. Jain and S. R. K. Iyengar,* **Advanced Engineering Mathematics**, 5th Edition, Narosa Publishers.

R2. *Robert T. Smith and Roland B. Minton,* **Calculus**, 4th Edition, McGraw Hill Education.

R3. *David C Lay,* **Linear Algebra and its application,** 3rd Edition,

R4. KENNETH HOFFMAN, **Linear Algebra,** 2nd Edition**,** PRENTICE-HALL, INC., Englewood Cliffs, New Jersey

Course Content

Module-I **Contact Hours: 6**

Matrices: Basic Operations on matrices and vectors, Determinants, Cramer Rule, Inverse of matrix using Gauss Jordan elimination, Rank of a matrix, Solution of system of linear equations: Gauss elimination.

Module-II **Contact Hours: 10**

Vector Spaces-I: Vector Space, Linear Independence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank, nullity, rank-nullity theorem, Inverse of a linear transformation, composition of linear maps, Matrix associated with a linear map.

Module III **Contact Hours: 10**

Vector Spaces-II: Eigen values, eigenvectors, symmetric, skew-symmetric, and orthogonal

Matrices,eigenbases, Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.

Module-IV **Contact Hours: 10**

Ordinary Differential Equations: Basic concepts, Exact differential equations, Linear differential equations of second and higher order with constant coefficients, Method of variation of parameters,Cauchy-Euler equation, System of linear differential equations with constant coefficients, applications oflinear differential equations.

Module-V **Contact Hours: 9**

Partial Differential Equation: Basic concepts, Classification of second order linear PDE, Method of separation of variables and its application in solving Wave equation (one dimension), heat equation (one dimension) and Laplace equation (two-dimension steady state only).

Module-VI

Normal form of matrices and It's Application

Compliance report

School of Basic and Applied Science							
Programme							
Programme Chair							
Compliance report of course handout							
Sl No	**Course code**	**Course title**	**Section**	**Taught by faculty**	**Course coordinator**	**Course handout Submission date**	**Remarks by PC if any**

Sigature of PC; **Signature of Dean:**

Review by IQAC: